Solid Immersion Lens for Improved Spatial Resolution in IR Microspectroscopy

M. Ramotowski, L.M. Miller, G.L. Carr (BNL, NSLS), P. Haymoz (U. Fribourg), and P. Schneider (ETH, Zurich)

Abstract No. Ramo2792
Beamline(s): **U10B**

Introduction: The spatial resolution for infrared microspectroscopy is limited by diffraction. The width of the microscope's diffraction pattern scales inversely with the optical system's numerical aperture (N.A.), so a large N.A. is desirable. An immersion microscope benefits from the increase in N.A. that occurs when the specimen is immersed in a higher refractive index material (such as oil). Similar results may be achieved using solid materials such as ZnSe, Si and Ge. We have made some initial tests of the resolution improvement when ZnSe (n=2.4) is used.

Results: The increased N.A. and hemispherical shape of an immersion lens leads to an image magnification equal to the refractive index. This is demonstrated in the visible light images of **Figure 1**. The view through the ZnSe shows opaque spheres, magnified 2.4 times compared to that observed through a window with plane parallel surfaces. The edge of a thin PMMA section was used to test the spatial resolution at infrared wavelengths. Transmission measurements were performed while scanning across the PMMA edge. The strength of an absorption feature at a wavelength of 6 microns is shown in **Figure 2** as a function of scanned position. The apparent PMMA edge sharpness is approximately 2 microns, which is about a factor of two better than would occur without the ZnSe hemisphere. Extraction of the absorption strength was complicated by light reflected from the specimen's edge, making the technique difficult to use in practice.

Conclusions: A resolution improvement is observed for thin, flat specimens, but reflections from neighboring surfaces contaminate some of the spectra. Additional refinements are necessary before the method becomes practical.

Acknowledgments: Research supported by DOE through contract DE-AC02-98CH10886 at the NSLS.

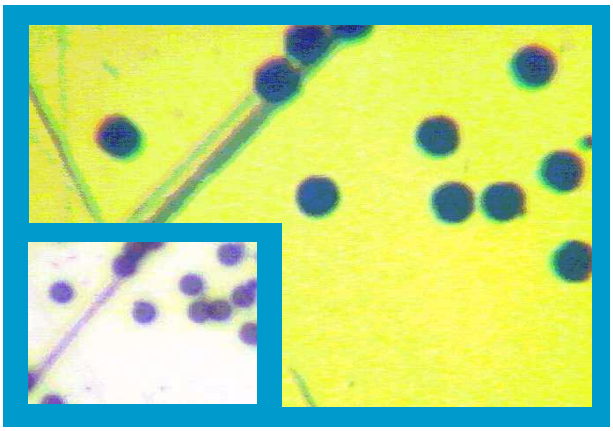

Figure 1. Image of several 6 micron diameter spheres viewed through ZnSe hemisphere (yellow background) and through a KBr window with plane parallel surfaces (white background).

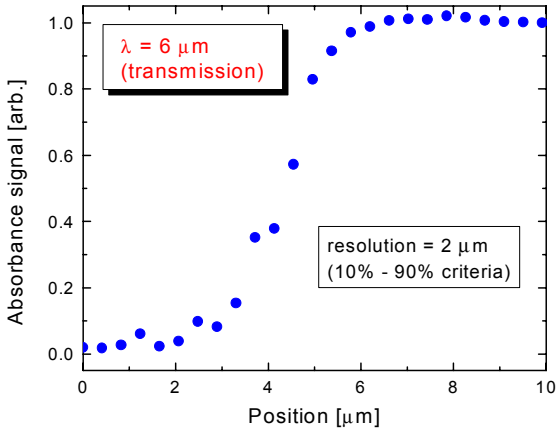

Figure 2. Absorption at 6 micron wavelength as a function of position when scanned across the edge of a PMMA specimen. The edge sharpness is about 2 microns, approximately 1/3 the wavelength.